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AN INEXPENSIVE, PORTABLE VIBRACORING SYSTEM FOR SHALLOW-WATER A--ETC(U)
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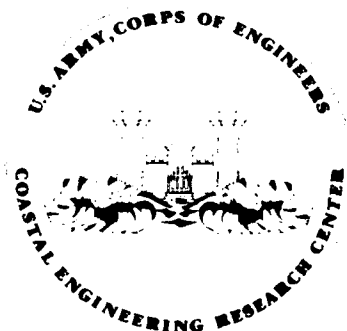
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An Inexpensive, Portable Vibracoring System for Shallow-Water and Land Application

by
Kenneth Finkelstein
and
Dennis Prins

COASTAL ENGINEERING TECHNICAL AID NO. 81-8

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the coring pipe (the clamp moves up and down the coring pipe like a "sleeve," eliminating having to completely remove the unit) and (b) a stable tripod with four separate, portable components. During extraction, the core is stabilized in a vertical position by a spring-loaded metal gate, using a core pipe slot cut into the tripod headplate, until extraction is completed.


PREFACE

This report is published to describe an efficient and effective system to obtain cores of unconsolidated sediments in saturated beach and back-barrier environments. The work was carried out under the coastal sedimentation research program of the U.S. Coastal Engineering Research Center (CERC).

The report was prepared by Kenneth Finkelstein, Geologist, and Dennis Prins, Physical Scientist, under the general supervision of Dr. C.H. Everts, Chief, Engineering Geology Branch, Engineering Development Division. The authors acknowledge Dr. R. Hobson and L. Hulmes for their help with the design of the coring system, and S.J. Williams for his review of the report.

Comments on this publication are invited.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.


TED E. BISHOP
Colonel, Corps of Engineers
Commander and Director

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CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	by	To obtain
inches	25.4	millimeters
	2.54	centimeters
square inches	6.452	square centimeters
cubic inches	16.39	cubic centimeters
feet	30.48	centimeters
	0.3048	meters
square feet	0.0929	square meters
cubic feet	0.0283	cubic meters
yards	0.9144	meters
square yards	0.836	square meters
cubic yards	0.7646	cubic meters
miles	1.6093	kilometers
square miles	259.0	hectares
knots	1.852	kilometers per hour
acres	0.4047	hectares
foot-pounds	1.3558	newton meters
millibars	1.0197×10^{-3}	kilograms per square centimeter
ounces	28.35	grams
pounds	453.6	grams
	0.4536	kilograms
ton, long	1.0160	metric tons
ton, short	0.9072	metric tons
degrees (angle)	0.01745	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins ¹

¹To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: $C = (5/9) (F - 32)$.

To obtain Kelvin (K) readings, use formula: $K = (5/9) (F - 32) + 273.15$.

AN INEXPENSIVE, PORTABLE VIBRACORING SYSTEM FOR SHALLOW-WATER AND LAND APPLICATION

by
Kenneth Finkelstein and Dennis Prins

I. INTRODUCTION

Vibratory coring devices have been used for the past three decades to obtain relatively undisturbed cores of unconsolidated sediments. Initially, pneumatic coring systems deployed from ships and barges were designed to obtain cores on the Inner Continental Shelf (Tirey, 1972; Meisburger and Williams, 1980). Several smaller portable vibrating coring devices have been developed that successfully recover cores in beach and back-barrier environments by small boat or vehicle. Sanders and Imbrie (1963) and Pierce and Howard (1969) designed systems that recover cores less than 12 feet (3.6 meters) long. Hoyt (1979) and Lanesky, Logan, and Hine (1979) developed efficient portable coring apparatuses to obtain cores up to 36 and 43 feet (11 and 13 meters) long, respectively.

To improve efficiency and safety, the Coastal Engineering Research Center (CERC) used modifications of existing coring systems to design a portable vibrating coring system for use in a sedimentation study of barrier islands. The essential components (see Table for equipment specifications) typify other portable vibrating coring designs: a gasoline-powered concrete vibrator, a 3-inch-diameter (7.6 centimeters) aluminum irrigation pipe 33 feet (10 meters) long, a 14-foot-high (4.3 meters) tripod with two come-alongs, and a gas-main sealer plug. The advantages of this design over previous systems include the easy assembly and the sturdiness of the tripod, which permits efficient, safe, yet rapid extraction of cores 33 feet or greater in length, and a quick fasten-release clamp to attach the vibrator head to the coring pipe. A method was also devised to extract less than 10-foot (3 meters) cores without the use of the 14-foot tripod. The entire coring system weighs about 220 pounds (100 kilograms), and the total cost to fabricate and assemble the apparatus and purchase the core tubes is less than \$1,000 discounting labor. The coring procedure may be accomplished entirely by two individuals, though three are desirable. This system is not intended for subsurface strength or density tests.

II. PRIMARY COMPONENTS

1. Vibrator.

A Briggs and Stratton 4-horsepower 4-cycle gasoline engine designed for use as a concrete vibrator is used as the power source of the coring system (see the Table for equipment specifications). The engine vibrator unit (Fig. 1) weighs 110 pounds (50 kilograms) and is assembled on a 360° swivel base. A 13-foot-long (4 meters) flexible shaft leading to the vibrator head is a standard attachment to the engine. However, an extra 13 feet of extension shaft is recommended so that the vibrator head can be attached as high as possible on the 33-foot coring pipe. This improves the system in two ways: (a) The vibrator head does not need to be moved up the core barrel until about 20 feet (6 meters) of pipe has penetrated the sediment. Momentum is very important in retrieving long cores. Reattaching the vibrator head one time is usually unavoidable, but making several reattachments is detrimental to achieving deep

Table. Equipment specifications.

VIBRATING UNIT

Gasoline engine:

Air-cooled, 4-cycle, 4-hp engine mounted on a 360° swivel base

Vibrator head:

<u>length</u>	<u>width</u>	<u>height</u>	<u>weight</u>	<u>centrifugal force</u>
14.56 in	2.375 in	2.375 in	12.0 lb	1,229 lb @ 10,000 vibrations per min

Flexible shaft, 2 ea:

<u>length</u>	<u>inner core diameter</u>
13 ft	3/8 in

Quick fasten-release clamp (3-in schedule 40 black pipe, halved and hinged with eyebolts):

<u>length</u>	<u>lb/ft</u>	<u>wall thickness</u>	<u>o.d.</u>	<u>i.d.</u>
8 in	7.58	0.216 in	3.5 in	3.068 in

TRIPOD HEAD (aluminum alloy 6061)

Plate:

<u>length</u>	<u>width</u>	<u>thickness</u>	<u>lb/ft²</u>
15 in	12 in	1 in	14.11

Leg supports (3-in schedule 40 pipe), 3 ea:

<u>length</u>	<u>lb/ft</u>	<u>wall thickness</u>	<u>o.d.</u>	<u>i.d.</u>
1.0 ft	2.62	0.216 in	3.5 in	3.068 in

TRIPOD LEGS (aluminum alloy 6061)

Legs (2.5-in schedule 40 pipe), 3 ea:

<u>length</u>	<u>lb/ft</u>	<u>wall thickness</u>	<u>o.d.</u>	<u>i.d.</u>
14.0 ft	2.00	0.203 in	2.875 in	2.469 in

Ladder rungs (round), 11 ea:

<u>length</u>	<u>diameter</u>	<u>lb/ft</u>
12 in	0.5 in	231

Pads, 3 ea:

<u>radius</u>	<u>thickness</u>	<u>lb/ft²</u>
6 in	0.5 in	7.06

Pivot plate, 6 ea:

<u>length</u>	<u>width</u>	<u>lb/ft²</u>	<u>thickness</u>
4.0 in	3.25 in	7.06	0.5 in

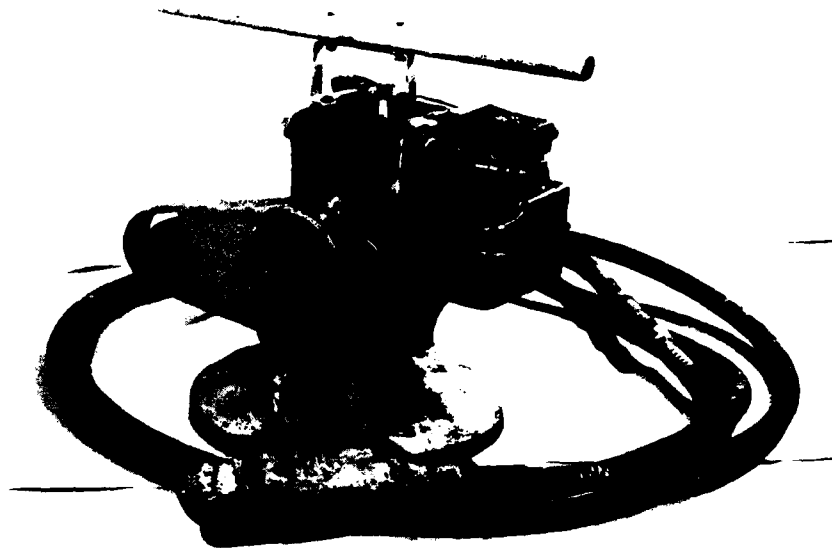


Figure 1. The gasoline engine power source, along with 26 feet of flexible extension shaft, the vibrator head, and the quick fasten-release clamp.

penetration of the core tube; during the short period of time it takes to shut down the engine and reattach the vibrator head some of the sediments will have already begun to densify. (b) The higher placement of the vibration head on the core tube has been shown to improve vibration and core penetration.

The quick fasten-release clamp, which is designed to rigidly and quickly attach the vibrator head to the coring tube, is made from a section of schedule 40 steel pipe (see Table for specifications) about 8 inches (20 centimeters) long (Fig. 2). The pipe was cut in half longitudinally, and each piece hinged on one side with two bolt plates and two slot plates welded near the top and bottom of the other side. The clamp which is welded to the vibrator head is then fastened around the coring pipe by two hex head bolts, nuts, and lock-washers. The quick fasten-release clamp may be moved up and down the coring pipe like a "sleeve" by simply loosening the nuts and bolts, eliminating having to completely remove the unit from the core tube. This design is an improvement over standard U bolts that often bend or break and take considerably more time for removal and reattachment.

2. Tripod.

Important criteria in coring are the sturdiness and the safety of the tripod used to extract the cores. The tripod shown in Figure 3 meets these criteria. It has four separate components: three 14-foot-long legs of schedule 40 aluminum pipe and an aluminum tripod head (see Table for specifications). Step supports welded to one leg provide easy attachment of the come-alongs to the tripod head. At the base of each leg is a 12-inch-diameter (30.5 centimeters) pivoting footpad which prevents the tripod legs from sinking into the ground during extraction of the filled core tube.



Figure 2. A closeup of the quick fasten-release clamp. The core fits snugly into the clamp and is tightened by two hex head bolts, nuts, and lockwashers.

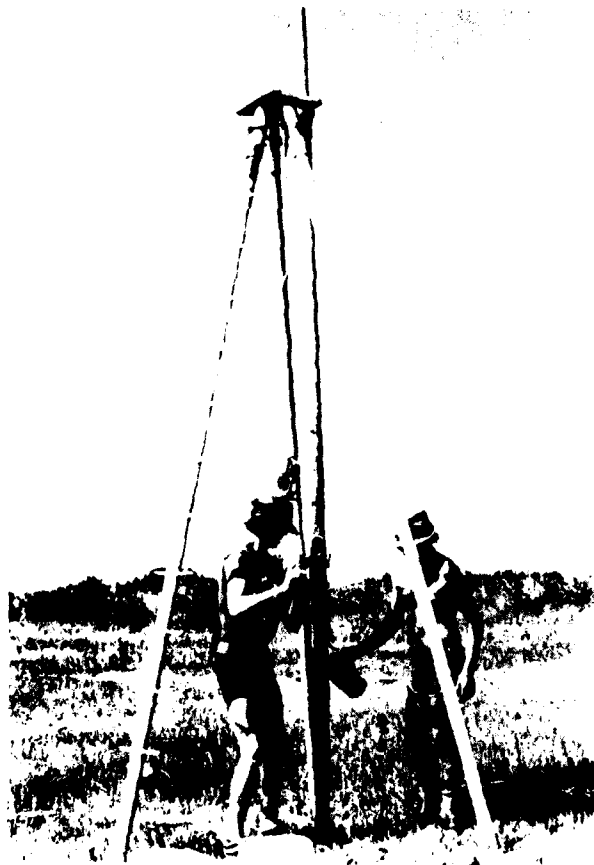


Figure 3. The 14-foot-high tripod with step supports welded to one leg. Extraction is accomplished with the use of two come-alongs attached to the headplate at the top of the tripod.

Three 12-inch-long tripod leg supports (see Table for specifications) were welded to the tripod head (Fig. 4). The legs were placed into the leg supports and held in place by 0.5-inch (1.3 centimeters) steel pins through each tripod leg and corresponding leg support. Two holes were drilled into the underside of the tripod head for installation of steel eyebolts to support the come-alongs during core extraction.

A further modification entails cutting a core pipe slot, 5 inches (12.7 centimeters) wide and 5 inches deep (rounded at the inside end), in the tripod headplate (Fig. 4). A metal spring-loaded bar, the slot gate, is placed across the core pipe slot. Attached to the end of the gate is a release cord to open and close the gate from ground level. During extraction, the core is guided through the slot and held vertical by the tripod. After the core breaks free of the sediment, the come-alongs are removed. The release cord is then pulled, opening the slot gate, and the core falls freely to the ground. This design permits a safe extraction of long cores often unobtainable with other coring systems.

III. SECONDARY COMPONENTS

Three-inch aluminum irrigation pipe, a gas-main sealer plug, hacksaws, and rope are all stock items and easily purchased. It is recommended that the bottom end of the core tube be cut at a 45° angle and sharpened with a file for easier penetration.

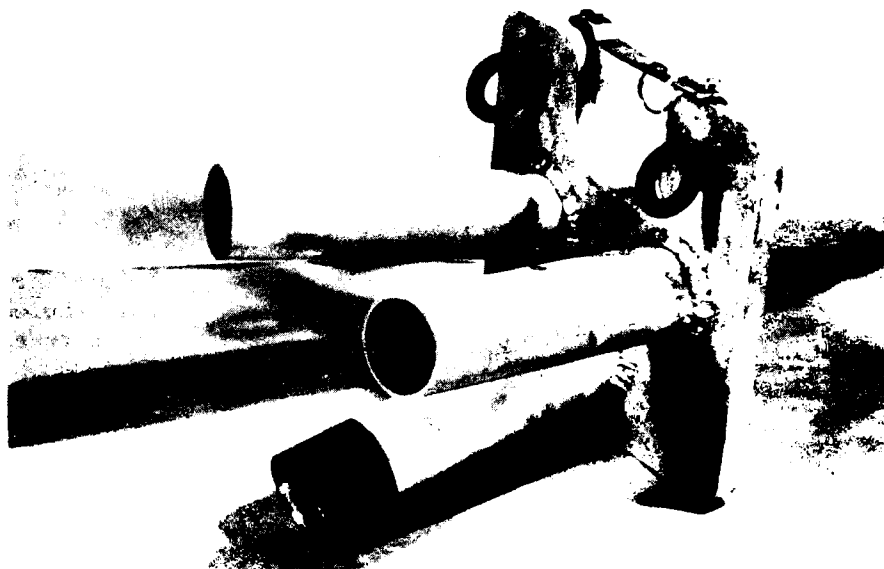


Figure 4. A closeup of the tripod headplate. Leg supports welded to the headplate are shown, along with the core pipe slot and spring-loaded slot gate with attached cord. The underside of the headplate has two steel eyebolts for fastening the come-alongs.

IV. CORING PROCEDURE

Vibracore sampling is divided into three steps: intrusion, extraction, and packaging.

1. Intrusion.

For maximum penetration, the vibrator head should be attached near the top of the unsharpened end of the 33-foot core barrel, while the barrel is lying on the ground. As one individual of the coring crew keeps a foot on the sharpened end to prevent movement away from the designated coring position, one or preferably two other individuals push the core pipe into a vertical position. Initially, the core barrel will sink into the saturated sediment by its own weight giving some stability. Unsaturated sediment can also be cored with this system but depth of penetration may be limited. A quick start of the engine will generally cause rapid penetration of the pipe into the sediment. Tying a rope to the pipe and pulling down by adding weight will aid in getting the pipe through resistant subsurface units such as rooted zones and oyster-beds. Usually, 15 to 25 minutes is needed to penetrate 33 feet of sediment.

2. Extraction.

After removing the vibrator head, the remaining pipe is cut off with a hacksaw about 1.6 feet (0.5 meter) above the ground surface. The distance to the sediment surface inside and outside the pipe is measured to determine the amount of sediment compaction. The pipe is then filled with water and a gas-main sealer plug is inserted and tightened to prevent loss of sediment from the core pipe as it is removed.

The tripod is assembled and placed over the intruded pipe. Two come-alongs are each fastened to the eyebolts at the tripod head and to a rope securely fastened to the core pipe. Extracting the core with the come-alongs (Fig. 3) is initially difficult but becomes easier once the core breaks free from the bottom. The core is guided through the core pipe slot in the tripod head and then rested against the tripod head to prevent falling over during extraction. The filled core barrel, weighing approximately 10 pounds per foot (15 kilograms per meter), cannot be gently lowered. Therefore, as mentioned previously, when the core is completely out of the sediment, the come-alongs are removed and the core pipe slot is opened by pulling the cord that moves the spring-loaded slot gate. The core is then gently pushed so that it falls freely to the ground (Fig. 5). The sample tube, completely filled except near the top, falls onto a relatively soft beach, marsh or aqueous medium. This prevents any disturbance except for the top 1 foot which may slump.

3. Packaging.

The extracted core is usually too long for immediate shipment, so the core is cut at the field site, using a hacksaw. Aluminum foil held securely with duct tape is sufficient as core caps. Each core section must be carefully labeled, indicating top and bottom, with a waterproof marker.

The splitting, logging, and sampling of each core is done in the laboratory. Immediate photographing of all the cores after opening is an important step that should not be neglected (Fig. 6). Even under the best conditions, complete preservation of a core is impossible.

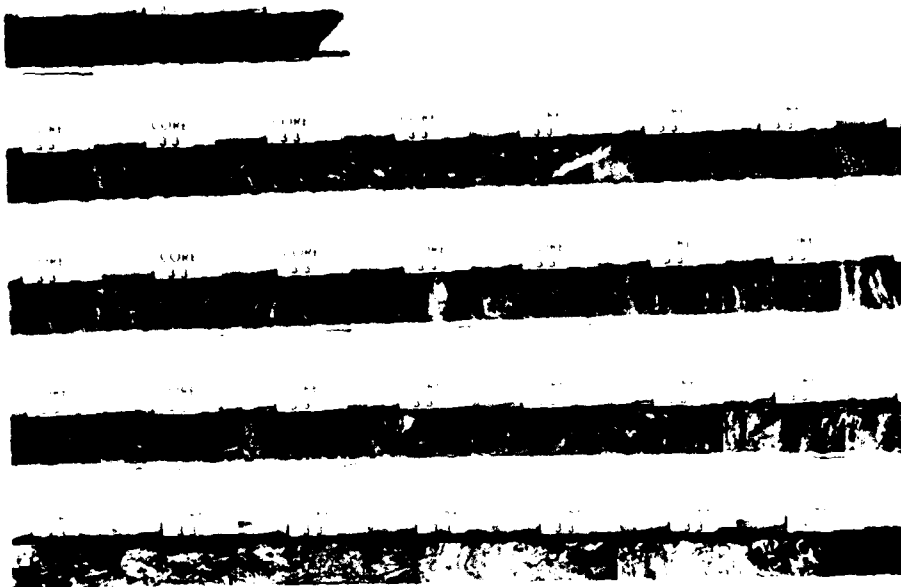


Figure 6. Photomosaic of an opened core.

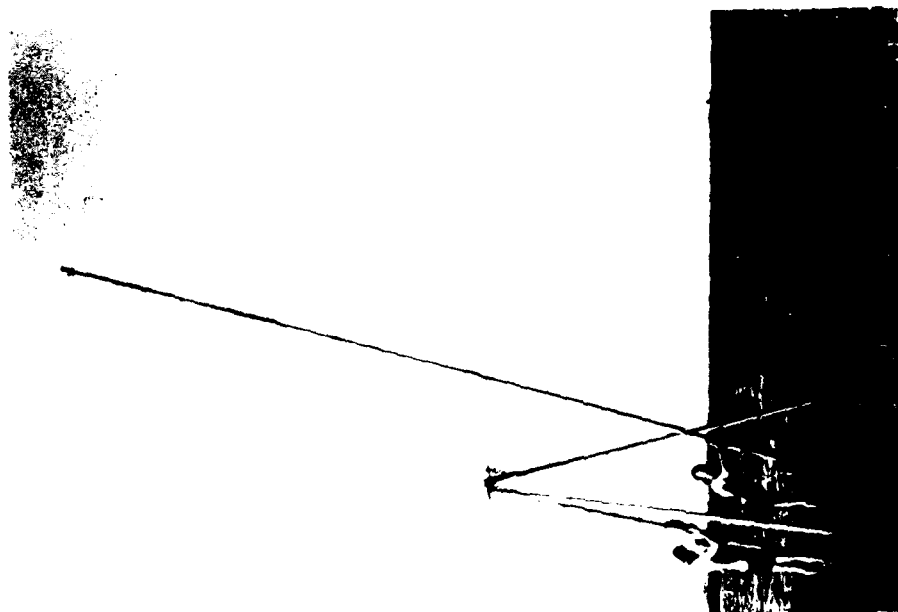


Figure 5. Removal of the extracted core from the tripod.

V. PROCEDURAL MODIFICATIONS

Coring procedures that provide increased flexibility may be used when short cores (≤ 10 feet) are sufficient, and weight and space limitations exist for transporting the coring equipment. In this case the entire tripod with the extra extension shaft is not needed; only the vibrating system, the pipe, one come-along, a gas-main sealer plug, and packaging materials are necessary, all of which can be transported by helicopter, small plane, or small boat. The cores are intruded and packaged as previously discussed. Extraction is simplified by using a 2- by 4-inch (5.1 by 10.2 centimeters) piece of sturdy wood, 6 feet (1.8 meters) long, or an extra piece of pipe in place of the tripod, as a bracing for the come-along. One hook of the come-along is attached to a rope securely tied to the core pipe, the other hook is fastened to the top of the makeshift support. One individual is sufficient to keep the support stable while another jacks the core out of the sediment (Fig. 7).



Figure 7. The modified coring procedure for collecting short cores.

VI. FIELD TESTS

During the summer of 1980, 35 cores, ranging from 13 to 33 feet long, were recovered along the coast of Virginia during a 3-week period. Later that year, nine additional cores, each 10 feet long, were recovered in 1 day by the modified coring method and transported to CERC by helicopter. No problems occurred during either field test.

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